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# MEASUREMENT OF THE ATMOSPHERIC LIGHT LAYER BY MEANS OF A ROCKET

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## 1. Introduction

What is atmospheric light?. How can one measure the height of the light layer, the main objective of this research?

This has already been mentioned in previous papers (this journal Vol. 13, No. 10).

The instrument, which was installed in the K-8-9 rocket, is slightly improved over the one used in K-8-5 and K-8-6, but is essentially the same.

The following describes the improvement in the instrument, with details of the instrument itself being omitted.

## 2. Instrument

The K-8-5 and the K-8-9 rockets are almost the same. They each include two light-collecting cylinders and their own photon tubes and amplifiers. They are as follows:

| Measurement, line band | Phototube | Filter |
|---|---|---|
| Oxygen green line & Sodium D line | Mazuda PM 50 | 3 interference filters |
| Near infra-red OH line band | RCA 7102 | Interference filter (7620 Å) and red filter |

The voltage for the phototube was produced from a battery through a transistorized electric circuit and transformer. This method had some disadvantages, such as lack of lifetime and instability of the battery.

In this experiment, a barrier-layer battery was used. This battery was connected with a fine Toshiba 0180 type 270-volt battery in series. It was installed in a large box (see center of Fig. 1) and each battery supplied the phototube cylinder through a wire on the inside of a glass tube. The box and phototube cylinder were both sealed tightly to prevent any discharge from the upper part. A filter was set in a case with a movable disc, the position of which is changeable by the continuous rotation of a micrometer. The disc has a metal plate which is coated with a photo luminous material, besides having its own filter, and this works as a standard light source. If it comes out, it shows as a standard light and is recorded for its intensity. There is a chopper between the filter and phototube that is rotated by a micro motor. The photo current is multiplied by an alternating current and supplied to the telemetry by the chopper.

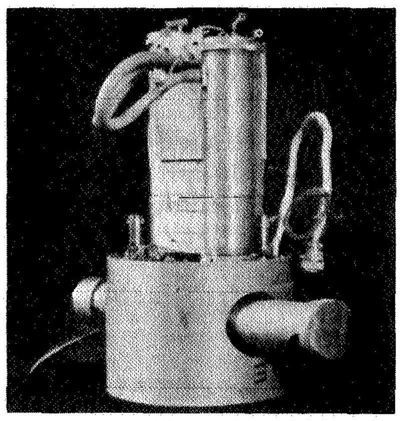

Fig. 1

3. Outline of Experiment

The experiment was performed at Akita, Japan, using a K-8-9 rocket. Launch was scheduled for October 29, 1961, but it was delayed one day due to bad weather. The experiment actually took place on October 30, 1961. The rocket was launched at 8:13 P.M. The altitude was 175 km.

The condition of the instrument was as follows: The light-collecting cylinder for infra-red was not working right. It opened eight seconds earlier than the expected time, which had been set for 62 seconds after launch, thereby injuring the phototube and the cylinder. The cylinder for the visible light opened exactly 65 seconds after take-off and worked quite well recording up to 175 seconds after the launch. Then, the noise level of the phototube got bigger and the readings were in error. We assumed the reason that it did not work was because the sealing of both the high-voltage battery and the cylinder of the phototube was not enough, resulting in discharge and low pressure.

The trouble with the infra-red cylinder was caused by parts that were misaligned, the vibration of which prevented the actuating spring from working.

The projection mechanism of the light-collecting cylinder was quite difficult. However, with the K-8-6 rocket this has not been successful because of trouble with the igniter. In the near future, it will be necessary to improve this mechanism. Figure 2 shows the standard light and atmospheric collected light recorded by the telemetry. Up to injection, the telemetry recorded only the standard light created by the fluorescent paint. However, right after injection, the atmospheric light was recorded also. It showed the intensity of starlight, excluding the atmospheric light band intensity. 5577 Å and 5893 Å should be calculated by subtracting these values. These values are the average of the intensity reached after passing the layer of atmospheric light and at the rocket altitude of more than 120 km. The value of 5300 Å is used as a check value. The recording of the standard light source showed that it looked like a mechanical noise. It was assumed that this noise was caused by the instability of the light source itself rather than by some mechanical noise of the phototube and/or amplifier. However, from these facts, it was confirmed that the sensitivity of both phototubes and amplifiers was not changed during the flight of this rocket. The lower chart of Fig. 2, as mentioned before, was caused by trouble with the phototube. The infra-red band could not yield any reasonable values at all, resulting from the trouble with the phototube, as shown in the lower chart of Fig. 2.

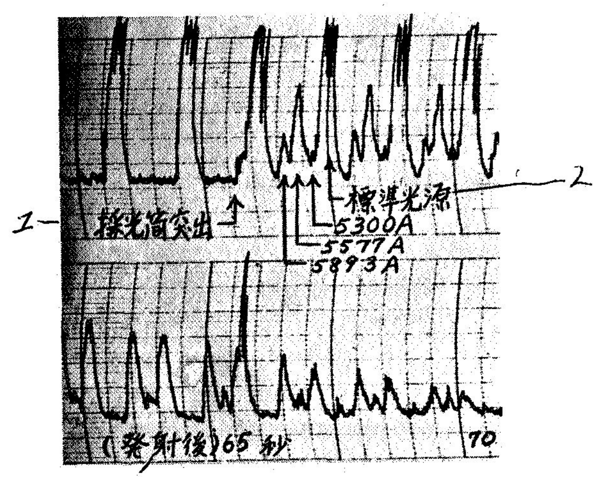


Fig. 2. Colorimetry record of light after and before projection of phototube (above-graph is for visual range of light; below-for infra-red light)

1) Projection of phototube; 2) Standard light source; 3) 65 sec after launching

4. Results

Figure 3 plots the atmospheric light intensity found during the experiment, the values being arrived at by subtracting the starlight intensity from the value of the recorder, as mentioned before. These points are scattered quite a bit due to the following:

First of all, there was the mechanical noise of the phototube and amplifier.

Second, the situation of the rocket itself.

The latter, as it happened, caused the following phenomena:

(1) The different traversed lengths of the layers of atmospheric light caused by the difference in angles of inclination between the rocket and the radiation layer of atmospheric light. If the angle is increased, the intensity is increased.

(2) The rocket faced different intensities of starlight at each moment, making the observation of the light intensity of starlight always a variable.

This phenomenon could only be avoided if the atmospheric light and starlight could be exposed to the rocket at the same time.

In Fig. 2, the intensity of the line value was negative after 90 seconds.

This meant that the exact value of starlight had not been subtracted from the atmospheric light intensity. If the position and attitude of the rocket could be observed simultaneously, this error could be resolved. This fact suggested that it would be practical to use an aspectometer.

However, according to the result of this experiment, the head of the rocket never faced downward, up to the point of highest altitude. If it faced downward, the atmospheric light would enter the rocket and the degree of intensity would be increased. If it is assumed that the rocket had passed through the layer of atmospheric light, keeping its head upward, the relation between the height of the atmospheric light line and the intensity analyzed from Fig. 3, would result in the drawing of Fig. 4. In this regard, the height of the layer of radiation is as follows:

| | | | |
|---|---|---|---|
| Oxygen green line | (5577 Å), | 89-113 km; | highest intensity, 98 km |
| Sodium D line | (5893 Å), | 88-110 km; | " " , 93.5 km |

This result is identical to the result of American observations.

The American experiment has been done in an area more than 10 degrees higher in latitude than in Akita. It was also the American purpose to discover the difference in the heights of the layer of radiation, but this difference should be included in the experimental error.

Summary:

The experiments regarding atmospheric light using rockets have just started.

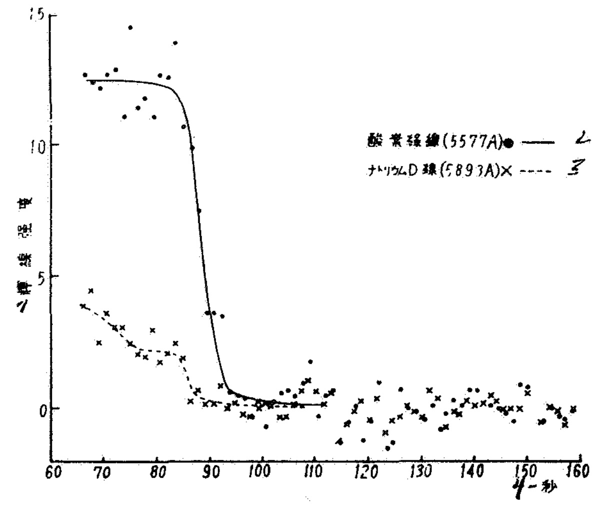

Fig. 3. Atmospheric light intensity shown from telemetry record of the visible spectrum (each value is obtained by subtracting 5300 Å, the star-light intensity)
1) Intensity of spectral band; 2) Oxygen green band (5577 Å); 3) Sodium D band (5893 Å) ; 4) sec

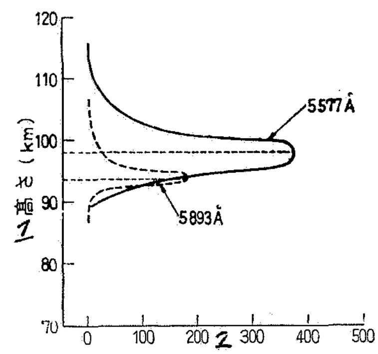

Fig. 4. Atmospheric light intensity vs altitude curves obtained by observation
1) Altitude; 2) Atmospheric light intensity

It is hoped to try to repeat the experiments to get more data, especially of the oxygen line red band (6300 Å), which has not yet been observed by rocket. This kind of experiment is expected from workers all over the world. It should be tried as soon as possible.

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